Researchers develop 'super' yeast that turns pine into ethanol

November 18 2011

Researchers at the University of Georgia have developed a "super strain" of yeast that can efficiently ferment ethanol from pretreated pine -- one of the most common species of trees in Georgia and the U.S. Their research could help biofuels replace gasoline as a transportation fuel.

"Companies are interested in producing ethanol from woody biomass such as pine, but it is a notoriously difficult material for fermentations," said Joy Doran-Peterson, associate professor of microbiology in the Franklin College of Arts and Sciences.

"The big plus for softwoods, including pine, is that they have a lot of sugar that yeast can use," she said. "Yeast are currently used in ethanol production from corn or sugarcane, which are much easier materials for fermentation; our process increases the amount of ethanol that can be obtained from pine."

Before the pinewood is fermented with yeast, however, it is pre-treated with heat and chemicals, which help open the wood for enzymes to break the cellulose down into sugars. Once sugars are released, the yeast will convert them to ethanol, but compounds produced during pretreatment tend to kill even the hardiest industrial strains of yeast, making ethanol production difficult.

Doran-Peterson, along with doctoral candidate G. Matt Hawkins, used directed evolution and adaptation of Saccharomyces cerevisiae, a species of yeast used commonly in industry for production of corn ethanol, to

generate the "super" yeast.

Their research, published online in *Biotechnology for Biofuels*, shows that the pine fermented with the new yeast can successfully withstand the toxic compounds and produce ethanol from higher concentrations of pretreated pine than previously published.

"Others before us had suggested that Saccharomyces could adapt to harsh conditions. But no one had published softwood fermentation studies in which the yeast were pushed as hard as we pushed them," said Doran-Peterson.

During a two-year period, Doran-Peterson and Hawkins grew the yeast in increasingly inhospitable environments. The end result was a strain of yeast capable of producing ethanol in fermentations of pretreated wood containing as much as 17.5 percent solid biomass. Previously, researchers were only able to produce ethanol in the presence of 5 to 8 percent solids. Studies at 12 percent solids showed a substantial decrease in ethanol production.

This is important, said Doran-Peterson, because the greater the percentage of solids in wood, the more ethanol that can be produced. However, a high percentage of solids also places stress on the yeast.

"Couple that stress with the increase in toxic compounds, and the fermentation usually does not proceed very well," she said.

Pine is an ideal substrate for biofuels not only because of its high sugar content, but also because of its sustainability. While pine plantations account for only 15 percent of Georgia's trees, they provide 50 percent of harvested timber, according to Dale Greene, professor of forest operations in UGA's Warnell School of Forestry and Natural Resources. The loblolly pine that Doran-Peterson and Hawkins used for their

research is among the fastest growing trees in the American South.

"We're talking about using forestry residues, waste and unsalable timber," said Peterson, "Alternatively, pine forests are managed for timber and paper manufacturing, so there is an existing infrastructure to handle tree-farming, harvest and transportation for processing.

"The basic idea is that we're trying to get the yeast to make as much ethanol as it can, as fast as it can, while minimizing costs associated with cleaning or washing the pretreated pine. With our process, no additional clean-up steps are required before the pine is fermented," she said.

More information: The paper is available online at www.biotechnologyforbiofuels.com/content/4/1/49/

Provided by University of Georgia